IN THE UNITED STATES DISTRICT COURT
FOR THE NORTHERN DISTRICT OF OKLAHOMA

Case No. 4:05-CV-329-GKF(SAJ)

STATE OF OKLAHOMA
Plaintiff

v.

TYSON FOODS, INC., et al.,
Defendants

Herman J. Gibb, Ph.D., M.P.H.
Tetra Tech Sciences
Arlington, VA 22201

Herman J. Gibb
Herman J. Gibb

December 1, 2008
Date

EXHIBIT
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13. In summary, the State of Oklahoma (ODEQ 2006a) 303d list reports nine water bodies in the IRW as impaired because of bacteria but does not report that any of the impairments are the result of the application of poultry litter; a variety of potential sources for these impairments are indicated. Furthermore, bacterial impairment of recreational waters occurs all over the State of Oklahoma; it is certainly not isolated to the IRW.

Bacterial Indicators

14. Dr. Teaf reports that microbial indicator organisms are commonly used and widely accepted measures of the potential for the presence of pathogens, including bacteria, viruses, and protozoa in recreational water and cites the National Research Council (NRC 2004), EPA (2005), and Wade et al. (2006) as references (paras 17, 21 Teaf 2008a).
15. NRC (2004) states: "The use of indicators is based on the presumption that they co-occur at a constant ratio with illness-causing pathogens. This premise is flawed because indicator levels in the gastrointestinal tract may vary within a narrow range, but pathogen concentration is highly variable and dependent on which pathogens are in the population at what levels at specific times. Furthermore, upon leaving the intestinal tract, microbial indicators and pathogens degrade at different rates that are mediated by factors such as their resistance to aerobic conditions, ultraviolet radiation, temperature changes, and salinity. As a result, the epidemiological relationship between indicator density and illness patterns can differ depending on the age of the source material, as well as local meteorological and other environmental conditions. Several studies also have found that some indicator bacteria can grow outside the human or animal intestinal system, further confounding the correlation between pathogens and indicators."
16. NRC (2004) further states: "The underlying epidemiologic studies are also limited because many reported failures of beach water quality standards are associated with nonpoint source, but the epidemiologic studies used to establish recreational bathing water standards have been based primarily on exposure to human fecal-dominated point source contamination. Since nonpoint sources generally have a higher percentage of animal fecal contributions, and animals shed bacterial indicators without some of the accompanying human pathogens, there is considerable uncertainty in extrapolating present standards to nonpoint source situations. A poor correlation between bacterial indicators and virus

concentrations has been found in the study of nonpoint sources and water quality. However, when a human source, such as septic systems, has been present, enterococci have been significantly correlated with viruses."

17. EPA (2005) states: "The works of several researchers has shown that these indicators (*E. coli* and enterococci) are not reliable surrogates for many pathogens including bacteria, and most viruses and parasites. New approaches for detecting pathogens are needed to improve monitoring systems."
18. Dr. Harwood states that the link between bacterial indicators and human illness from recreational waters has been demonstrated in many epidemiological studies (para 23, Harwood 2008) and that indicator water quality standards have been supported since EPA's (1986) ambient quality criteria were published (para 26, Harwood 2008). Harwood et al. (2005), however, found that indicator organisms, including enterococci, were a poor predictor of pathogens including enteric viruses, cryptosporidium, and giardia.
19. Dr. Teaf (para 21, Teaf 2008a) claims that "These indicator organisms, such as *E. coli*, enterococci, and fecal coliform bacteria, may not cause illness directly, but they have demonstrated characteristics which make them reliable indicators of other harmful pathogens in water" and cites Wade et al. (2006) as a reference. Wade et al. (2006), however, provides no endorsement of *E. coli* or enterococci as indicator organisms and never mentions fecal coliform as an indicator organism. This was a study of a quantitative polymerase chain reaction method for evaluating enterococci and bacteroides as indicators for gastrointestinal illness. The authors stated: "Because this is the first and only study to evaluate the ability of rapid water-quality indicators to predict GI [gastrointestinal] illness, additional studies will be required to evaluate the generalizability of these findings. Additional studies and analyses will help determine whether these preliminary findings are consistent and robust enough from a regulatory perspective to recommend a rapid indicator for recreational water quality, and to evaluate the conditions under which such indicators can successfully be applied." Furthermore, the beaches studied were specifically selected because they were affected by discharges from waste treatment plants.
20. Dr. Harwood claims that acute febrile respiratory illness (AFRI) has been linked in epidemiology studies to elevated microbial pollution levels and cites Fleisher et al. (1998) as a reference (para 7, Harwood 2008). Dr. Harwood also claims that children are among

those most likely to contract gastrointestinal illness from swimming (para 9, Harwood 2008), citing Cabelli et al. (1979) and Pruss (1998) as references. Fleisher et al. (1998) reported an increased risk of AFRI associated with bathing in sewage-contaminated water. Cabelli et al. (1979) was also a study of swimmers in sewage-contaminated water. Six of the 23 studies reviewed by Pruss (1998) were fresh water studies; three of those reported the bacterial source to be sewage; the bacterial source in the other studies was not stated. These results are highly questionable in evaluating risks from non-human sources such as poultry litter, as it is widely believed that human feces pose a larger health risk than animal feces to swimmers and other primary contact recreational water users (WHO 2003).

21. In 2000, Congress passed the Beaches Environmental Assessment Act requiring the completion of studies on pathogen indicators in coastal recreational waters within 3 years and the publication of new or revised water quality criteria for pathogens and pathogen indicators within 5 years (BEACH 2000). When EPA failed to publish new Ambient Water Quality Criteria (AWQC) for bacteria in 2005, the Agency was sued by the Natural Resources Defense Council (NRDC). As part of its response to the action by the NRDC, the EPA (2007a) convened a panel of experts to obtain "input from individual members of the broad scientific and technical community on the critical path research and related science needs." The purpose of the research was to support "new or revised AWQC by 2012."

22. Dr. Harwood and Dr. Teaf both claim that EPA's expert panel (EPA 2007a) placed the highest priority for research on recreational water quality on pathogens from poultry and other agricultural animals (e.g., cattle, sheep) (para 38, Teaf 2008a; para 10, Harwood 2008). The table to which Drs. Teaf and Harwood refer in the EPA (2007a) report (Table 5) places the highest research priority on epidemiologic studies at beaches impacted by fecal contamination from "other agricultural animals (e.g., cattle, sheep)" and not beaches impacted by fecal contamination from poultry. More importantly regarding agricultural animals, EPA (2007a) states that "Current epidemiological literature suggests that the symptomatic profile of swimming-associated illnesses indicates primarily viral illnesses.....With rare exception, viruses are species-specific. Essentially, all enteric oral/fecally transmitted viruses that infect humans are of human origin." Consequently EPA (2007a) assigned a negligible risk to viruses of animal (including poultry) origin.

23. Dr. Harwood claims that WHO (2003) has adopted "standards" for water quality based on indicator bacteria (para 26, Harwood 2008). The WHO (2003) guidelines for recreational water are based on microbial water quality assessment (as measured by enterococci) and sanitary inspection. The sanitary inspection described by WHO is principally driven by human fecal inputs to the recreational water. WHO states that one of the bases of their approach is the movement away from sole reliance on fecal indicator bacteria. The approach allows a water quality assessment category to be given a more favorable category when bacterial contamination is from non-human sources.
24. Dr. Harwood states that a re-analysis by Wade et al. (2003) of 27 epidemiology studies strongly supports the relationship between indicator bacteria (*E. coli* and enterococci) concentrations and gastroenteritis rates in recreational water users. Dr. Harwood further states that enterococci are responsible for many of the water quality exceedances throughout the IRW and that this group of fecal indicator bacteria "are correlated with the risk of gastroenteritis in fresh and salt water" (para 30, Harwood 2008). Wade et al. (2003), however, found that "no increase in relative risk was observed for high levels of enterococci compared with low levels." Commenting on Wade et al. (2003), the NRC (2004) stated, "there was no best (consistent) indicator of gastrointestinal illness in freshwater."
25. Dr. Harwood concluded that indicator bacteria standards will "doubtless be used to protect the health of recreational waters in the U.S. for the foreseeable future" based on a report by EPA's expert panel (EPA 2007a). EPA (2007a) did not endorse the current AWQC for bacteria; furthermore, they recommended research on a variety of approaches, not simply limited to indicator bacteria.
26. Following the EPA (2007a) report, EPA (2007b) developed a Critical Path Science Plan to answer what the Agency considered to be the key questions in the development of a new or revised AWQC. Prior to the plan, EPA had already embarked on an extensive multibillion dollar research program, including both in-house and extramural research, to improve the science of the AWQC (Grumbles 2007, Haugland et al. 2005, Wade et al. 2006, Wade et al. 2008, EPA 2008b).
27. In summary, the validity of indicator bacteria has been challenged by expert panels formed by EPA or at the request of EPA, and it is anticipated that EPA will publish new AWQC by

2012 (NRC 2004, EPA 2007a, EPA 2007b). To this end, EPA is engaged in an extensive research program to improve the science of the AWQC, and EPA (2007b) has developed an extensive research plan to ensure that the new or revised criteria are scientifically sound.

EPA Ambient Water Quality Criteria (AWQC) for Bacteria

28. Dr. Teaf refers to the U.S. EPA (2003) *Draft Implementation Guidance for Ambient Water Quality Criteria for Bacteria*[2] (paras 21-23, Teaf 2008a). He states that these draft guidelines report that a geometric mean density of 126 *E. coli* per 100 milliliters (mL) of water and a geometric mean density of 33 enterococci per 100 mL of water over a 30-day period are associated with an illness rate of 8 illnesses per thousand recreational users.
29. The AWQC for bacteria were developed by EPA (1986) based on "acceptable risk". The determination of "acceptable risk" derives from a recommendation made by the National Technical Advisory Committee (NTAC 1968). NTAC cited studies done in the late 1940s and early 1950s at Lake Michigan and on the Ohio River in which an "epidemiologically detectable health effect" was found to occur between 2,300 and 2,400 total coliforms per 100 mL. Studies conducted on the Ohio River over a decade later estimated that 18 percent of the total coliforms were fecal coliforms (i.e. about 400 fecal coliforms per 100 mL). The NTAC (1968) recommended fecal coliforms as a better indicator of disease than total coliforms and recommended using a safety factor of two, resulting in a Water Quality Criteria of 200 fecal coliforms/100 mL for primary recreational waters as an acceptable risk.
30. The epidemiologic studies which became the basis of the AWQC were conducted at beaches at Lake Erie, Pennsylvania and Keystone Lake, Oklahoma between 1979 and 1982. Two beaches were studied at each location. At both locations, the source of the bacteria was treated sewage. Persons studied were swimmers and nonswimmers at the two beaches. Swimming activity was rigidly defined as having all upper body orifices exposed to the water. The determination of illness was based on telephone interviews conducted 8 to 10 days after the individuals swam at the beach. A statistically significant increase in "highly credible gastrointestinal symptoms (HCGI)" was found only at the beach with

[2] The Final Implementation Guidance for Ambient Water Quality Criteria for Bacteria was published in 2004 (EPA 2004b).